

What is claimed is:

1. A photonic crystal-based resonant cavity, comprising:
 - a first dielectric substance having a first dielectric permittivity;
 - a plurality of second dielectric substances each having a second dielectric permittivity, the plurality of second dielectric substances being arranged in a first periodic structure with respect to at least one or more directions on a plane formed of the first dielectric substance;
 - a plurality of third dielectric substances each having a third dielectric permittivity, the plurality of third dielectric substances being arranged in a second periodic structure with respect to at least one or more directions on the plane formed of the first dielectric substance, and being disposed in unit cells formed by the plurality of second dielectric substances so as to be arranged in a third periodic structure together with the plurality of second dielectric substances; and
 - one or more local defects formed to disrupt either the first periodic structure formed by the second dielectric substances or the second periodic structure formed by the third dielectric substances.

2. The photonic crystal-based resonant cavity as claimed in claim 1, wherein the third dielectric substances have the largest possible size that is capable of being inserted in a unit cell formed by the plurality of second dielectric substances without overlapping the second dielectric substances.

3. The photonic crystal-based resonant cavity as claimed in claim 1, wherein the plurality of third dielectric substances are disposed on border lines between the unit cells formed by the plurality of second dielectric substances.

4. The photonic crystal-based resonant cavity as claimed in claim 1, wherein the second dielectric permittivity is greater than the first dielectric permittivity.

5. The photonic crystal-based resonant cavity as claimed in claim 4, wherein the third dielectric permittivity is greater than the first dielectric permittivity and less than the second dielectric permittivity.

6. The photonic crystal-based resonant cavity as claimed in claim 1, wherein the one or more defects are formed by omitting dielectric substances at a predetermined position in the first periodic structure of the plurality of second dielectric substances or in the second periodic structure of the plurality of third dielectric substances.

7. The photonic crystal-based resonant cavity as claimed in claim 1, wherein the one or more defects are formed by changing a size or a shape of one or more of the plurality of second dielectric substances at a predetermined position in the first periodic structure of the plurality of second dielectric substances or by changing a size or a shape of one of one or more the plurality of third dielectric substances in the second periodic structure of the plurality of third dielectric substances.

8. The photonic crystal-based resonant cavity as claimed in claim 1, further comprising a waveguide in the first dielectric substance for causing electromagnetic waves to reach the one or more defects.

9. A resonator having a plurality of filtering frequencies, comprising:

a cavity having:

a first dielectric substance having a first dielectric permittivity;

a plurality of second dielectric substances each having a second dielectric permittivity, the plurality of second dielectric substances being arranged in a first periodic structure with respect to at least one or more directions on a plane formed of the first dielectric substance;

a plurality of third dielectric substances each having a third dielectric permittivity, the plurality of third dielectric substances being arranged in a second periodic structure with respect to at least one or

more directions on the plane formed of the first dielectric substance,
and being disposed in unit cells formed by the plurality of second
dielectric substances so as to be arranged in a third periodic structure
together with the plurality of second dielectric substances; and

one or more local defects formed to disrupt the first periodic
structure formed by the plurality of second dielectric substances or
the second periodic structure formed by the plurality of third dielectric
substances;

a first waveguide in the first dielectric substance and integrated
adjacent to the one or more defects for causing electromagnetic waves to
reach the one or more defects; and

a second waveguide in the first dielectric substance integrated
adjacent to the one or more defects for outputting the electromagnetic waves
generated by the cavity in a desired direction.

10. The resonator having a plurality of filtering frequencies as claimed in claim 9, wherein the first waveguide is an input waveguide for channeling incident electromagnetic waves to the one or more defects.

11. The resonator having a plurality of filtering frequencies as claimed in claim 9, wherein the second waveguide is an output waveguide for emitting electromagnetic waves generated by the cavity formed by the one or more defects in a desired output direction.

12. The resonator having a plurality of filtering frequencies as claimed in claim 9, wherein the first waveguide and the second waveguide may be formed either on opposite sides of the one or more defects or on the same side of the one or more defects.